Appendix 6

Complete list of aquatic coleoptera species recorded on SSSI Unit 3, Catfield Fen

The following table documents all aquatic coleoptera species recorded on SSSI Unit 3 and their presence in the 2004 and 2014 surveys. The conservation status of each species is noted, with Nationally notable species are highlighted in orange and Red Data Book species are highlighted in red.

		TG 366 211		TG 367 210		TG 368 210		TG 367 212		TG 369 211		TG 370 212		TG 371 212		TG 371 213	
		1		2		3		4		5		6		7		8	
		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Species	**Status**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**
Haliplus ruficollis							X			X		X	X			X	X
Peltodytes caesus	Nb						X										
Noterus clavicornis				X	X	X	X	X	X			X					X
Noterus crassicornis	Nb							X				X	X			X	
Hygrobia hermani			X														
Laccophilus minutus			X														
Colymbetes fuscus															X		
Hyphydrus ovatus		X	X	X	X	X	X	X	X	X		X	X			X	X
Hydroglyphus pusillus	Nb											X					

		TG 366 211		TG 367 210		TG 368 210		TG 367 212		TG 369 211		TG 370 212		TG 371 212		TG 371 213	
		1		2		3		4		5		6		7		8	
		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Species	**Status**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**
Hygrotus decoratus	Nb				X				X	X	X	X		X	X	X	
Hygrotus inaequalis						X	X	X	X	X		X				X	
Hygrotus versicolor								X									
Hygrotus impressopunctatus										X							
Hydroporus angustatus			X				X	X	X	X		X		X	X	X	
Suphrodytes dorsalis										X	X	X		X	X	X	
Hydroporus erythrocephalus			X				X		X	X		X		X		X	
Hydroporus glabriusculus	RDB 3									X				X			
Hydroporus gyllenhali			X					X		X				X			
Hydroporus melanarius								X		X				X			

		TG 366 211		TG 367 210		TG 368 210		TG 367 212		TG 369 211		TG 370 212		TG 371 212		TG 371 213	
		1		2		3		4		5		6		7		8	
		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Species	**Status**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**
Hydroporus neglectus	Nb							X		X	X			X			
Hydroporus palustris							X		X			X				X	
Hydroporus pubescens										X							
Hydroporus scalesianus	RDB 2							X		X	X	X		X	X		
Hydroporus striola												X				X	
Hydroporus tristis					X			X	X	X	X	X		X	X		
Graptodytes granularis	Nb				X				X	X	X	X		X	X	X	X
Graptodytes pictus						X											
Porhydrus lineatus		X						X		X		X				X	
Laccornis oblongus	Na {RDB 3}							X						X			
Copelatus haemorrhoidalis					X		X			X		X		X	X	X	

		TG 366 211		TG 367 210		TG 368 210		TG 367 212		TG 369 211		TG 370 212		TG 371 212		TG 371 213	
		1		2		3		4		5		6		7		8	
		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Species	**Status**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**
Agabus bipustulatus					X		X		X		X			X	X		
Agabus striolatus	RDB 2									X							
Agabus sturmi										X	X	X				X	
Agabus unguicularis	Nb							X		X			X	X			
Ilybius ater																	
Ilybius fuliginosus																	
Ilybius guttiger	Nb				X					X		X		X	X		
Ilybius quadriguttatus						X				X		X	X			X	X
Rhantus exsoletus												X				X	
Rhantus grapii	Nb						X			X	X		X	X	X	X	X
Rhantus suturalis	(Nb)								X								
Dytiscus semisulcatus							X										
Hydaticus seminiger	Nb	X	X			X		X		X		X	X		X		X

		TG 366 211		TG 367 210		TG 368 210		TG 367 212		TG 369 211		TG 370 212		TG 371 212		TG 371 213	
		1		2		3		4		5		6		7		8	
		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Species	**Status**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**
Hydaticus transversalis	Na {RDB 3}					X	X	X				X	X				X
Graphoderus cinereus	RDB 3						X					X	X			X	X
Dytiscus dimidiatus	Na {RDB 3}											X				X	
Gyrinus paykulli	Na					X										X	
Gyrinus marinus		X	X	X		X										X	X
Gyrinus suffriani	Na {RDB 3}		X	X	X		X							X			
Hydrochus angustatus	Nb					X						X				X	
Hydrochus brevis	RDB 3				X					X		X	X	X			
Hydrochus ignicollis	RDB 3					X						X	X			X	X
Hydrochus megaphallus	RDB 2			X		X		X	0	X	X	X				X	
Helophorus flavipes										X							
Helophorus grandis												X					

		TG 366 211		TG 367 210		TG 368 210		TG 367 212		TG 369 211		TG 370 212		TG 371 212		TG 371 213	
		1		2		3		4		5		6		7		8	
		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Species	**Status**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**
Helophorus minutus										X							
Helophorus obscurus														X			
Coelostoma orbiculare						X	X	X	X	X							
Cercyon convexiusculus	Nb				X			X									
Hydrobius fuscipes					X	X	X	X		X		X	X	X	X	X	
Anacaena globulus															X		
Anacaena limbata			X		X	X	X	X	X	X				X	X	X	
Anacaena lutescens					X					X		X		X		X	
Laccobius bipunctatus								X	X								
Laccobius colon			X														
Laccobius minutus							X										
Helochares obscurus	RDB 3				X	X		X			X	X	X	X	X	X	X

		TG 366 211		TG 367 210		TG 368 210		TG 367 212		TG 369 211		TG 370 212		TG 371 212		TG 371 213	
		1		2		3		4		5		6		7		8	
		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Species	**Status**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**
Enochrus coarctatus	Nb				X	X	X	X	X	X	X	X	X	X	X	X	X
Enochrus halophilus	Na											X					
Enochrus nigritus	RDB 3									X							
Enochrus melanocephalus	Nb									X							
Enochrus ochropterus	Nb									X	X			X			
Enochrus testaceus						X	X		X			X	X	X		X	
Cymbiodyta marginellus										X		X			X		
Chaetarthria seminulum	Nb											X				X	
Hydraena palustris	RDB 2									X				X			
Hydraena riparia			X		X		X	X		X					X		X
Hydraena testacea	Nb											X	X		X	X	

		TG 366 211		TG 367 210		TG 368 210		TG 367 212		TG 369 211		TG 370 212		TG 371 212		TG 371 213	
		1		2		3		4		5		6		7		8	
		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Species	**Status**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**	**2004**	**2014**
Limnebius aluta	Na {RDB 3}		X		X		X	X	X	X	X	X	X	X	X	X	
Ochthebius minutus							X				X						
Dryops anglicanus	RDB 3		X		X	X	X	X	X	X		X		X	X	X	X
Dryops luridus						X											
Total Number of species		5	X9	8	3X	33	35	44	X4	69	X8	69	3X	53	36	55	X8

Appendix 7

RDB invertebrate species records for the Catfield Fen area obtained from the National Biodiversity Network

In order to better understand the invertebrate community of SSSI Unit 3 the RSPB requested records from the National Biodiversity Network. These resulted in an impressive species list, as set out in the table below. The information will help inform management and monitoring requirements of the site.

Sutton Fen	Catfield Fen	Ant Valley	Order	Group	Scientific name	English name	Status	Ecology notes	Last recorded	Distribution notes	Ant only
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Agabus (Gaurodytes) striolatus*		Vulnerable	Temporary, shaded pools in carr in the Broads. Cannot fly.	2004	Confined to Norfolk	
No	No	Yes	Insecta	Beetles (Coleoptera)	*Agabus labiatus*		Near Threatened		2007		
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Bidessus unistriatus*	a diving beetle	Critically Endangered		2007		
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Dryops anglicanus*		Near Threatened	Wet veg at edge of fen and carr. Often with tussocks	2014	15 UK sites	
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Dytiscus dimidiatus*		Near Threatened	Rich fen veg, drains and ponds	2003		
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Enochrus nigritus*		Near Threatened	Mesotrophic base rich fens	2003		
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Graphoderus bilineatus*		Extinct		1906	Probably no longer preset at Catfield	
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Graphodorus cinereus*		Vulnerable	Vegetated pools and ditches	2014	3 UK sites. Declining.	
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Gyrinus suffriani*		Vulnerable	Edges of reedbeds, shallow runnels, dykes	2014	Handful UK sites.	
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Haliplus (Liaphlus) variegatus*		Vulnerable		2007		
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Helochares obscurus*		Vulnerable	Pools in sphagnum	2014	11 UK sites	
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Hydraena palustris*		Near Threatened	Temporary, stagnant water with marginal vegetation.	2014	14 UK sites	
No	Yes	Yes	Insecta	Beetles (Coleoptera)	*Hydrochus brevis*		Near Threatened	Weedy pools and thick fen veg in shade and mud	2014	25 UK sites	
No	Yes	Yes	Insecta	Beetles (Coleoptera)	*Hydrochus crenatus*		Near Threatened	Mossy margins of ponds and in rich fens	2004		
No	Yes	Yes	Insecta	Beetles (Coleoptera)	*Hydrochus elongatus*		Near Threatened		2007		
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Hydrochus megaphallus*		Vulnerable	Shallow pools in sphagnum	2014	5 UK sites	
No	Yes	Yes	Insecta	Beetles (Coleoptera)	*Hydrochus ignicolis*		Near Threatened	Thick veg at edge of dykes	2014	18 UK sites	
No	Yes	Yes	Insecta	Beetles (Coleoptera)	*Hydrophilus piceus*		Near Threatened	Dykes with thick submergent veg	2014	Fairly widespread but declining	

Sutton Fen	Catfield Fen	Ant Valley	Order	Group	Scientific name	English name	Status	Ecology notes	Last recorded	Distribution notes	Ant only
No	No	Yes	Insecta	Beetles (Coleoptera)	*Hydroporous longicornis*		Near Threatened				
No	Yes	Yes	Insecta	Beetles (Coleoptera)	*Hydroporus glabriusculus*		Vulnerable	Flooded moss carpets	2004	12 UK sites	
Yes	Yes	Yes	Insecta	Beetles (Coleoptera)	*Hydroporus scalesianus*		Vulnerable	Often in neutral or base-rich water, but associated with acidic conditions in Holland. Cannot fly, and is unable to colonise new sites.	2014	16 UK sites	
No	Yes	Yes	Insecta	Beetles (Coleoptera)	*Laccornis oblongus*		Near Threatened	Old fen systems shallow mossy areas of base rich fen	2003		
No	Yes	Yes	Insecta	Beetles (Coleoptera)	*Limnebius aluta*		Near Threatened	Edges of pools and muddy ditches, wet moss, litter in fens.	2014	21 UK sites	
No	No	Yes	Insecta	Beetles (Coleoptera)	*Limnoxenus niger*		Near Threatened				
Yes	No	Yes	Insecta	Beetles (Coleoptera)	*Quedius (Quedius) balticus*		Endangered	Needs litter.			
Yes	No	Yes	Insecta	Beetles (Coleoptera)	*Stenus (Stenus) proditor*		Data Deficient				
Yes	No	Yes	Insecta	Bees, ants, and wasps (Hymenoptera)	Odynerus (Spinicoxa) simillimus	fen mason-wasp	Endangered	A mason wasp. Requires bare ground in wetlands.	2014	Confined to <10 coastal sites in Norfolk and Suffolk	
Yes	No	Yes	Insecta	Bees, ants, and wasps (Hymenoptera)	Trogus lapidator		Data Deficient		2007	Only recent UK record - Catfield Fen	Yes
Yes	No	Yes	Insecta	Caddis Flies (Trichoptera)	*Agrypnia picta*		Data Deficient		2009	Incorrect record? No Broads records, very rare nationally.	
Yes	No	Yes	Insecta	Caddis Flies (Trichoptera)	*Erotesis baltica*		Vulnerable	Not well known, but no special requirements mentioned.	2007	Very scarce 7 site nationally	
Yes	Yes	Yes	Insecta	Dragonflies (Odonata)	*Aeshna isosceles*	Norfolk Hawker	Endangered	Should only need general fen management. Threatened by sea level rise.	2014	Confined to East Anglia	
Yes	Yes	Yes	Insecta	Dragonflies (Odonata)	*Coenagrion pulchellum*	Variable Damselfly	Near Threatened		2014	Widespread, increasing	
Yes	No	Yes	Insecta	Dragonflies (Odonata)	*Cordulia aenea*	Downy Emerald	Least concern		2010		
Yes	Yes	Yes	Insecta	Dragonflies (Odonata)	*Libellula fulva*	Scarce Chaser	Near Threatened	Pools or slow flowing rivers with not too much shade.	2007	Widespread SE England	
Yes	No	Yes	Mollusca	Molluscs	*Oxyloma (Oxyloma) sarsi*	slender amber snail	Vulnerable	Emergent vegetation at the edge of lakes and rivers. Could be threatened by over-grazing.	2007	Broads stronghold a few other sites	
Yes	No	Yes	Mollusca	Molluscs	*Segmentina nitida*	Shining Ram's-horn Snail	Endangered	Needs appropriate ditch management.	2014	Widespread but scarce S England	
Yes	No	Yes	Mollusca	Molluscs	*Vertigo moulinsiana*	Desmoulin's whorl snail	Vulnerable at European level		2007	Widespread SE England	
Yes	No	Yes	Insecta	Moths and Butterflies (Lepidoptera)	*Elachista pomerana*	Fen dwarf	Endangered	In *Calamagrostis* and probably other grasses in fens.	2014	3 sites in UK	

Sutton Fen	Catfield Fen	Ant Valley	Order	Group	Scientific name	English name	Status	Ecology notes	Last recorded	Distribution notes	Ant only
Yes	No	Yes	Insecta	Moths and Butterflies (Lepidoptera)	*Gelechia muscosella*	Grey sallow groundling	Near threatened	Catkins of *Salix* and *Populus* in wetlands	2008	5 UK sites	
Yes	Yes	Yes	Insecta	Moths and Butterflies (Lepidoptera)	*Limenitis camilla*	White Admiral	Vulnerable		2014	Widespread SE England	
Yes	Yes	Yes	Insecta	Moths and Butterflies (Lepidoptera)	*Papilio machaon*	Swallowtail	Near threatened	Feeds on Milk Parsley. This should be favoured by current management.	2014	Confined to Broads. Ant stronghold	
Yes	Yes	Yes	Insecta	Moths and Butterflies (Lepidoptera)	*Pelosia obtusa*	Small Dotted Footman	Endangered	Old, dense, uncut reedbeds. Some areas will need to be left uncut for this species, but they should not be allowed to become woodland.	2014	Confined to Ant Valley and Thurne valley. Big stronghold in Ant	
Yes	Yes	Yes	Insecta	Moths and Butterflies (Lepidoptera)	*Phragmataecia castaneae*	Reed Leopard	Vulnerable	In reed stems in permanently wet or seasonally flooded ground.	2014	2 UK sites. Ant valley stronghold	
Yes	No	Yes	Arachnida	Spiders	*Baryphyma gowerense*		Data Deficient		1988	A few sites in Wales. Only Ant valley in England	
Yes	No	Yes	Arachnida	Spiders	*Carorita paludosa*		Vulnerable	No recent British records, but unlikely to be found without intensive survey. Sympathetic fenland management should suit.	1990	Confined to Ant Valley	Yes
Yes	No	Yes	Arachnida	Spiders	*Clubiona juvenis*		Vulnerable	In fens and reedbeds, fresh or brackish.	2009	Confined to Broads	
Yes	No	Yes	Araneae	Spiders	*Theridian hemerobium*		Unclassified		2007	< 20 sites widely spaced	
Yes	No	Yes	Insecta	True bugs (Hemiptera)	*Calligypona reyi*		Data Deficient		2007	Incorrect record? No Broads records, very rare nationally.	
Yes	No	Yes	Insecta	True bugs (Hemiptera)	*Macrosteles oshanini*		Data Deficient		1988	Ant valley and one other UK site	
Yes	No	Yes	Insecta	True bugs (Hemiptera)	*Paraliburnia clypealis*		Data Deficient		2007	Confined to Ant valley	Yes
Yes	No	Yes	Insecta	True bugs (Hemiptera)	*Microvelia buenoi*		Nationally Rare		2007	< 10 sites all East Anglia	
Yes	No	Yes	Insecta	True flies (Diptera)	*Anopheles algeriensis*		Data Deficient		2007	5 UK sites	
Yes	No	Yes	Insecta	True flies (Diptera)	*Anticheta brevipennis*		Vulnerable	Prefers lush vegetation and ditches that have not been cleared for some time. Threatened by too much grazing.	2007	South England, very localised	
Yes	No	Yes	Insecta	True flies (Diptera)	*Calamoncosis aspistylina*		Data Deficient		2007	3 sites, other 2 in Hampshire and Warwickshire	
Yes	No	Yes	Insecta	True flies (Diptera)	*Cephalops perspicuus*		Near Threatened	Should benefit from general reedbed management.	1990	Very scarce, Broads, Suffolk coast, Pembroke coast	
Yes	No	Yes	Insecta	True flies (Diptera)	*Colobaea pectoralis*		Vulnerable	No specific needs mentioned.	1988	Confined to East Anglia	
Yes	No	Yes	Insecta	True flies (Diptera)	*Cryptonevra consimilis*		Vulnerable	No information in review.	2007	3 UK sites. (Ant, Chippenham, Wicken)	
Yes	No	Yes	Insecta	True flies (Diptera)	*Dolichopus laticola*	"Broads Dolli fly"	Endangered	Not known, but no specific requirements mentioned	2007	Confined to Bure and Ant valley	

Sutton Fen	Catfield Fen	Ant Valley	Order	Group	Scientific name	English name	Status	Ecology notes	Last recorded	Distribution notes	Ant only
Yes	No	Yes	Insecta	True flies (Diptera)	*Erioptera meijerei*		Vulnerable	General wetland management.	2007	Very scarce, a few sites Norfolk and a handful elsewhere	
Yes	No	Yes	Insecta	True flies (Diptera)	*Odontomyia angulata*		Endangered	Fens and shallow pools. Seasonal fluctuation might be important.	2007	4 UK sites	
Yes	No	Yes	Insecta	True flies (Diptera)	*Odontomyia argentata*		Vulnerable	Rotational ditch cleaning might be important.	2007	Confined to SE England, scarce	
Yes	No	Yes	Insecta	True flies (Diptera)	*Odontomyia ornata*		Vulnerable	Needs rotational ditch cleaning and shallow margins.	2007	Confined to SE England, scarce	
Yes	No	Yes	Insecta	True flies (Diptera)	*Parhelophilus consimilis*		Vulnerable		1988	Very rare, scattered sites nationally	
Yes	No	Yes	Insecta	True flies (Diptera)	*Pherbellia argyra*		Vulnerable	Wetlands, where it feeds on snails.	2008	<10 UK sites	
Yes	No	Yes	Insecta	True flies (Diptera)	*Platypalpus pygialis*		Data Deficient		2007	Only 1 UK record	Yes
Yes	No	Yes	Insecta	True flies (Diptera)	*Psacadina zernyi*		Vulnerable	Wetlands, where it feeds on snails.	2007	<20 UK sites	
Yes	No	Yes	Insecta	True flies (Diptera)	*Pteromicra leucopeza*		Vulnerable	Shaded ponds and swamps. Feeds on snails.	2007	<10 UK sites	
Yes	No	Yes	Insecta	True flies (Diptera)	*Rhamphomyia breviventris*		Vulnerable	Perhaps in wet woodland and fens.	2007	Only UK site	Yes
Yes	No	Yes	Insecta	True flies (Diptera)	*Scathophaga tinctinervis*		Vulnerable	No information in review.	2007	5 UK sites	
Yes	No	Yes	Insecta	True flies (Diptera)	*Stenomicra delicata*		Vulnerable	No information in review.	2007	Only UK site	Yes
Yes	No	Yes	Insecta	True flies (Diptera)	*Achalcus nigropunctatus*		Unclassified		2007	Only UK site ever recorded	Yes
Yes	No	Yes	Insecta	True flies (Diptera)	*Antichaeta analis*		Nationally Rare		2007	Very scattered <20 UK sites. Mostly Norfolk	
Yes	No	Yes	Insecta	True flies (Diptera)	*Ditrichophora nectens*		Unclassified		2007	Very scarce and scattered <10 sites.	
Yes	No	Yes	Insecta	True flies (Diptera)	*Hybomitra muelfeldi*		Nationally Rare		2007	Very scarce and scattered <10 sites.	
Yes	No	Yes	Insecta	True flies (Diptera)	*Notiphila subnigra*		Unclassified		2007	2 other UK sites (Norfolk coast and Dorset). A few in Wales.	
Yes	No	Yes	Insecta	True flies (Diptera)	*Ochthera manicata*		Nationally Rare		2007	Very scarce, Norfolk and Cambridgeshire	
Yes	No	Yes	Insecta	True flies (Diptera)	*Paradelphomyia czizekiana*		Unclassified		2007	New to UK, a couple of other sites too now	
Yes	No	Yes	Insecta	True flies (Diptera)	*Parydra undulata*		Unclassified		2007	New to UK, 1 other site in Cambridgeshire	
Yes	No	Yes	Insecta	True flies (Diptera)	*Stenomicra cogani*		Nationally Rare		2007	< 10 sites widely spaced	

Sutton Fen	Catfield Fen	Ant Valley	Order	Group	Scientific name	English name	Status	Ecology notes	Last recorded	Distribution notes	Ant only
Yes	No	Yes	Insecta	True flies (Diptera)	*Tetanocera freyi*		Not classified		2007	< 20 sites widely spaced	

Appendix 8

Detailed accounts of habitat management on SSSI Unit 3, Catfield Fen

1. The following presents the best available information regarding historic management of SSSI Unit 3. Present management is documented for comparison. The SSSI Unit is divided into a number of different compartments. These are presented in Figure 1.

[redacted]

Figure 1: Map showing the compartments on Butterfly Conservation owned Catfield Fen.

Habitat management of SSSI Unit 3 pre-1992

2. The RSPB has not been able to access detailed records of management of SSSI Unit 3 prior to ownership by Butterfly Conservation. However, available information indicates that the site was managed through a combination of commercial sedge, commercial reed, conservation cutting management and scrub management and non-intervention with some small areas of marsh hay / fen litter cutting. The primary objective was maintenance of wildlife value and for that reason the site was entered into a management agreement with the Nature Conservancy Council from 1973 (Keith McDougall *Pers. Comm.*). Beyond the commercial beds, much of the open fen was undergoing scrub encroachment before 1992 as highlighted in The Fen Resource Survey:

"herbaceous vegetation dominated by reed, sedge and pinreed, covers most of the site, large areas are extensively birch, alder and sallow."[1,2]

Habitat Management of SSSI Unit 3 in 1992

3. Butterfly Conservation purchased SSSI Unit 3 in 1992. The available records indicate that no habitat management was coordinated by BC in this year, though commercial sedge cutting continued (Andy Hewitt *Pers. Comm*.). Work in this year focussed on assessing the site and identifying management requirements from 1993 onwards.

Habitat management of SSSI Unit 3 between 1993 and 1997

4. The first management plan sought to maintain the commercially cut areas whilst embarking on a programme of restoration of areas described as 'recoverable scrub'. The plan detailed a five-year work programme to achieve the 'ideal state'. Defined in the 1993 'Agreed Management Policy' with English Nature as:

   "The land should be managed to maintain and enhance its conservation interest especially of those species whose existence are threatened within the Norfolk Broads. The dykes should be managed in the best interest of the aquatic flora and fauna. Areas of fen which have been cleared of invading scrub should be managed so that they remain open. Rotational cutting of sedge and reed should continue where it is viable."

5. The majority of work during this period was carried out by the reed and sedge cutter who was employed as a contractor to carry out additional habitat management, largely bank mowing and scrub removal by hand. This was supplemented by volunteer work parties.

6. The following projects were completed during this period:

   - Restoration of [redacted] by removing scrub using tracked excavator and digging adjacent ditches to build bank around north, west and east sides of [redacted];
   - Continuation of commercial sedge mowing in [redacted];
   - Patchy commercial sedge mowing in [redacted];
   - Restoration of commercial reed to [redacted] (where cutting had been abandoned in recent years, but is understood to have occurred historically) was made by carrying out restoration cuts;
   - Patchy scrub control on [redacted];
   - Regular mowing of banks and paths for access; and
   - Following advice about the importance of wet areas for invertebrates and bitterns, the 'new turf pond' was dug in the south-west corner of [redacted]. This involved lowering of approx. 0.5ha of peat and creation of banks to the south and west.

7. Over the four year period 1993 – 1997 this resulted in 1.8ha being cleared of scrub to restore open fen, approximately 3ha of commercial sedge cutting, the excavation of 0.6km of ditch and the restoration of 1.2ha of commercial reed through a non commercial cut. All of this work was carried out in agreement with English Nature. At the end of this management plan period, no

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[1] Parmeter, J. Broadland Fen Resource Survey.

[2] Giller, K.E., & Wheeler, B.J. (1982). *Species richness of herbaceous fen vegetation in Broadland, Norfolk, in relationship to the above-ground plant materia*l. Journal of Ecology **70:** 179-200.

concerns were raised by English Nature about site condition and the site remained in Favourable condition.

Habitat management of SSSI Unit 3 between 1997 and 2003

8. By 1997, although scrub clearance had been carried out as described above and there had been no reduction in the areas of cut sedge and an increase in the area of cut reed, there was still considered to be an excess cover of scrub. The 1997 site management statement described the long term management of the site to achieve the overall objective of maintenance of habitat diversity;

   - Commercial sedge – summer cutting (July to September) and removal of crop on 3 to 4 year rotation
   - Commercial reed – winter cutting (mid Dec to mid March) and removal of crop on 2 year – rotation
   - Unmanaged reedbed – scrub removal as necessary to maintain open habitat. Removal of brushwood from site if possible. If not, keep the number of bonfires to a minimum to avoid enrichment
   - Mixed Fen – summer cutting (June to September) and removal of crop on a minimum 4 year rotation. Need for cut to be partly determined by extent of scrub developments
   - Mixed fen for biofuel – summer cutting on a 4 to 10 year rotation.
   - Marsh hay – annual summer cut at 10cms above ground level and removal of crop
   - Mature woodland – non intervention
   - Coppiced woodland – coppicing on a 10 to 15 year rotation
   - Acidophilic vegetation – occasional clearance of birch by hand to prevent over shading of *Dryopteris*
   - Birch copse – hand removal of birch saplings to maintain copse at present size
   - Turf pond and open water – non-intervention

9. The following projects were completed during this period:

   - Continuation of commercial sedge mowing in [redacted];
   - A trial restoration cut of the southern part of [redacted] was undertaken, but this proved unsuccessful with the resulting vegetation too rich in grass (probably purple small reed) and not of commercial quality. The area was considered to be too dry. (Andy Hewitt, Pers. Comm.);
   - A trial restoration cut of [redacted] (an area not cut under previous ownership), but this proved to have limited success. The new banks constructed during the previous period are considered to have led to excessive water levels and stagnation during summer months and poor sedge growth. Sedge continued to be harvested here, but on a very long rotation (Andy Hewitt, Pers. Comm.);
   - Continuation of patchy commercial sedge mowing in [redacted];
   - Continuation of commercial reed in [redacted] on an annual wale following successful restoration cuts.

10. Over the six year period 1997 – 2003, 3.32ha of scrub was cleared, 6.45ha of commercial sedge was cut, 0.4km of ditch was managed and 8ha of commercial reed was cut on a single wale. All

of this work was carried out in agreement with English Nature. At the end of this management plan period, no concerns were raised by English Nature about site condition and the site remained in Favourable condition.

Habitat management of SSSI Unit 3 between 2003 and 2008

11. By 2003, scrub had continued to invade the site. This was despite continuation of the historic commercial reed and sedge cutting and increased effort to retard scrub succession and maintain access banks. It had become clear that Catfield Fen tended to scrub up very rapidly, possibly due to historically high levels of scrub (and high seed burden) and due to relative dryness of parts of the site compared with other fen sites in the Broad (such as Sutton Fen).

12. A new, more detailed management plan was written in accordance with the NNR plan requirements determined by English Nature. This Management Plan included more detail on site geology, hydrology, flora and fauna as well as management objectives and a detailed work plan.

13. Following the management review, the following actions were undertaken during the period 2003 to 2008 (as documented in the 2008 – 2013 management plan):

    - Commercial sedge harvesting continued on [redacted] and the Island.
    - Reed harvesting continued annually on [redacted], the bed now commercially productive and within an annual rotation.
    - Commencement of a rolling program of ditch edge management took place by removing overhanging scrub and trees, the aim to ensure 25% of dyke edges should have been recently cleared.
    - Scrub removal on the edges of the new turf pond in [redacted] to retain open conditions.
    - Patchy scrub clearance in [redacted], [redacted] and the Island.
    - Two small ponds were dug by hand on [redacted] as a Plantlife experiment to monitor reproduction of Crested Buckler Fern.

14. Over the six year period 2003 - 2008, 1.3ha of scrub was cleared, 5.5ha of commercial sedge was cut 0.5km of ditch was managed and 3ha of commercial reed was cut. Due to poor reed crops, 4ha of reed was cut without taking a harvest in an attempt to restore commercial quality. All of this work was carried out in agreement with English Nature. At the end of this management plan period, no concerns were raised by English Nature about site condition and the site remained in Favourable condition.

15. During this plan period, invertebrate surveys were conducted in 2003 and 2004. These revealed the national importance of the site for water beetles, many of which were associated with ‘scrubby fen’; any management now had to recognise the needs of the invertebrate interest of the site.

Habitat management of SSSI Unit 3 between 2008 and 2013

16. By 2008, there had been a continuation of the historic commercial reed and sedge cutting and continued effort to maintain scrub levels, which now stood at approx 15% of the open fen area (Catfield Fen Management plan 2008 – 2013). The importance of the small scrub was now known to be a key feature for maintenance of invertebrate communities. However, efforts to prevent further succession of scrub continued. Scrub encroachment continued to occur rapidly, particularly on drier parts of the site. In 2010, Natural England changed their assessment of the condition of the site to unfavourable declining due to inappropriate scrub control. A need to reduce scrub cover further, to 10% cover was agreed and the control was facilitated through a series of ESA and then HLS Capital payments and increased levels of volunteer involvement. In 2011, the commercial reedbed in [redacted] became unsuitable for reed production. This was considered to be due to drying and acidification despite regular management (see section 4 for a description of the successional processes happening at Catfield Fen). To ensure continuity of management for the plant community in this area, the reedbed cutting continued on a non-commercial, short rotation winter cut as agreed with Natural England and Plantlife (the latter involved due to the discovery of *Liparis loeselii* in this area). In 2011, in response to concern about drying of the site, a new pond was dug in [redacted] by removing alder scrub and digging with an excavator.

17. As documented in the 2013 to 2018 management plan, the following projects were completed:

- Continuation of commercial sedge cutting;
- Continuation of commercial reed cutting until 2011 followed by non-commercial fen cutting;
- Restoration of over 1ha of [redacted] from scrub to open fen;
- Scrub clearance of 1.4ha from [redacted] and [redacted];
- Annual cutting of 0.3ha in [redacted] to increase flowering plant diversity;
- Continuation of hand dyke clearance and bank cutting.

18. Over the five year period 2008-2013, 4.2ha of scrub was cleared, 3.0ha of commercial sedge was cut, 0.9km of ditch was managed, 3.65Ha of commercial reed was cut and 1.63Ha of non commercial fen was cut. All of this work was carried out in agreement with Natural England and regular communication with the site SSSI and ESA / HLS advisors. During this period, no concerns were raised about site management by Natural England except for highlighting an unacceptably high level of scrub on the site that was the reason for the site condition changing to Unfavourable declining despite continued efforts to control scrub since 1992. Since this change, additional funding has enabled further work to tackle the scrub encroachment.

Habitat management of SSSI Unit 3 in 2013 and 2014.

19. By 2013, there had been a continuation of the historic commercial sedge cutting and significant progress in returning the site to acceptable scrub levels. The latest management plan highlights the importance of maintenance of some scrub areas for invertebrate communities and an appropriate level was agreed with NE and RSPB Reserves Ecologists, this required a further 2.4Ha of scrub removal. Past hand clearance of dykes had helped keep them open, and allowed continued flow of water, but this was not adequate to ensure boat access around the site for both the commercial sedge cutter and other management activities. Therefore the new HLS agreement provided funding for further scrub removal and ditch restoration work.

20. To date, the following work has been completed under the 2013 – 2018 management plan:

- Continuation of commercial sedge cutting;
- Continuation of 1.5ha non commercial reed cutting of [redacted];
- Continuation of 0.3ha annual cut on [redacted];
- Commencement of patchy non-commercial fen cutting to south of [redacted], [redacted], on [redacted] and on [redacted];
- Removal of 2.4ha of scrub across the site and further patchy rogueing;
- Restoration of 1.3km of dykes through excavation.

21. All of this work was carried out in agreement with Natural England. To date, no concerns have been raised by Natural England about site management though the site remains in Unfavourable declining condition due to; Inappropriate scrub control (time will be required for fen habitats to recover following removal), freshwater – water abstraction and other (loss of habitat suitable for fen orchid).

Present and recent habitat management at Sutton Fen

22. At present, following the completion of scrub removal works in 2014, the levels of scrub communities, commercial sedge cutting, non-commercial conservation cutting and maintenance of open fen is as required through the site HLS agreement and as described in the current site management plan.

23. Sutton Fen (SSSI Units 8, 10 and 24) has been managed as an RSPB reserve since 2007. Prior to this, it was privately owned with varying degrees of conservation and commercial management carried out through the 20th Century. Although no thorough comparison between Sutton Fen and Catfield Fen of site management histories is carried out here, from our knowledge as managers of both sites, we are aware that the management histories have been broadly similar (periods of intensive commercial management, periods of relative neglect leading to scrub encroachment, periods of significant scrub clearance and more recently, management typical of a Broadland fen nature reserve with a variety of both commercial and non commercial management techniques; including reed and sedge cutting, dyke maintenance, non commercial fen cutting, scrub management and small scale turf ponding).

24. Sutton Fen demonstrates a variety of successional stages of historically turf ponded fen, with both recent (19th and 20th century) and medieval (13th and 14th century) areas of peat digging. Like Catfield Fen, the formerly turf ponded areas (the majority of the site) are undergoing successional processes. Unlike Catfield Fen, this has not led to a deterioration of the nature conservation interests. Indeed, Sutton Fen is often cited as an exemplar within the Broads and nationally as a fen site that is delivering well against its nature conservation objectives – including increases in Fen Orchid, consistently high swallowtail and Norfolk hawker counts, increases in 7 key RDB fen plant species, colonisation of new ponds by Shining Ramshorn snail and a return of cranes as a breeding species.

25. These successes have largely been achieved through sensitive and targeted conservation management in consultation with Natural England and underpinned by management plans. The methods have been broadly similar to conservation efforts at Catfield Fen. The RSPB wrote the latest Catfield Fen management plan underpinned by the same knowledge and experience that

informed the Sutton Fen management plan. The sites are similar in terms of the percentage of open fen managed, with 40% of the Open Fen at Catfield in regular rotational management and 36.5% of Sutton in regular rotational management. The level of recent turf ponding has been higher at Catfield Fen than Sutton Fen (3.8% and 1.0%).

26. Sutton Fen and Catfield Fen are managed in broadly the same way, though with some site and species specific tailoring. If management was the driver behind the changes occurring at Catfield Fen, then those changes would be expected to be occurring at Sutton Fen and at other sites in the Broads under a similar management regime and with similar historic management.

27. Though the RSPB does have significant concern about potential impact of water abstraction on Sutton Fen the SSSI features are currently in favourable condition and this demonstrates the efficacy of current and recent habitat management techniques.

Appendix 9

Catfield and Sutton Fen pH Surveys 2014

1. pH surveys at Catfield Fen

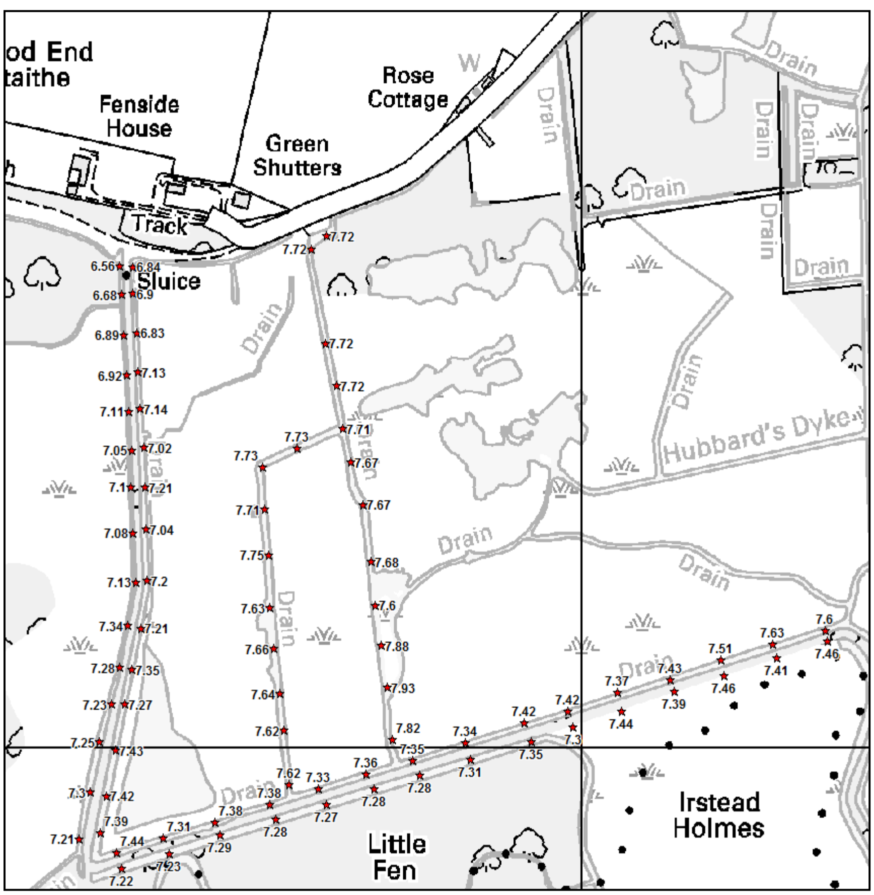
Summary:

1. To investigate general dyke pH to identify potential groundwater (or other alkaline) water inputs to the Catfield Fen dykes and to measure relative pH of internal and external dyke systems.

<u>2nd October 2014 dyke pH survey</u>

Method:

2. Following a period of dry weather, surface dyke pH was tested at 81 locations using a Hanna HI98129 probe from 10AM to 4PM on 2nd October 2014. The probe was calibrated with pH 7 and 10 buffers solutions before and after sampling with a shift of + 0.03pH units at pH7 and +0.07pH units at pH 10 during the day. Water was sampled by inserting the tip of the probe approx. 3cm from the water surface and approx. 50cm from the dyke edge. Areas of algae were avoided and the probe was rinsed with distilled water between each sample. Locations were recorded using a Garmin GPSmap 62 and edited on MapInfo to correct known error. Locations as mapped are accurate to within at most 10m.



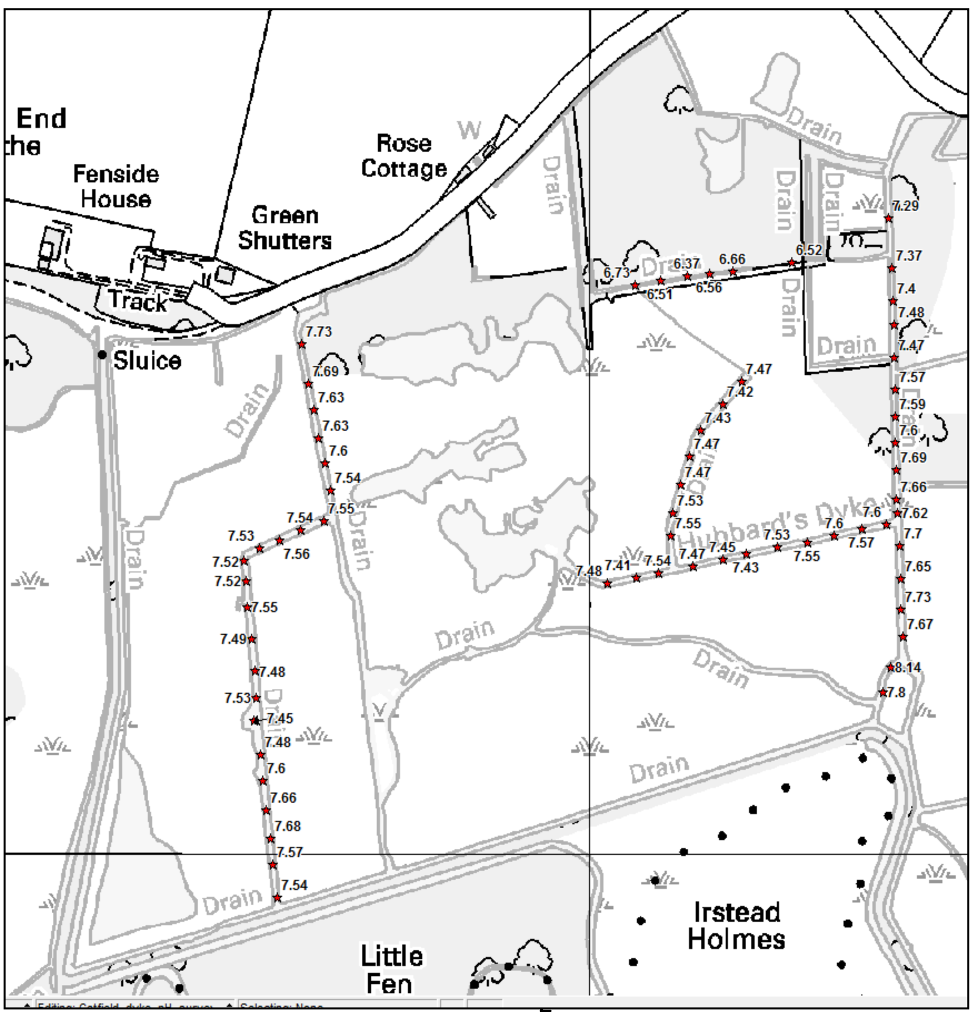
Results:

Average pH of all samples; 7.37 (n = 81)
Average of external adjacent rond: 7.20 (n = 30)
Average of internal adjacent rond: 7.29 (n = 30)
Average of other internal: 7.71 (n = 21)

10th October 2014 dyke pH survey

Method

3. Following a period of wet weather, surface dyke pH was tested at 64 locations using a Hanna HI98129 probe from 10AM to 4PM on 10th October 2014. The probe was calibrated with pH 7 and 10 buffers solutions before and after sampling with a shift of + 0.06pH units at pH7 and +0.04pH units at pH 10 during the day. Water was sampled by inserting the tip of the probe approx. 3cm from the water surface and approx. 50cm from the dyke edge. Areas of algae were avoided and the probe was rinsed with distilled water between each sample. Locations were recorded using a Garmin GPSmap 62 and edited on MapInfo to correct known error. Locations as mapped are accurate to within at most 10m.



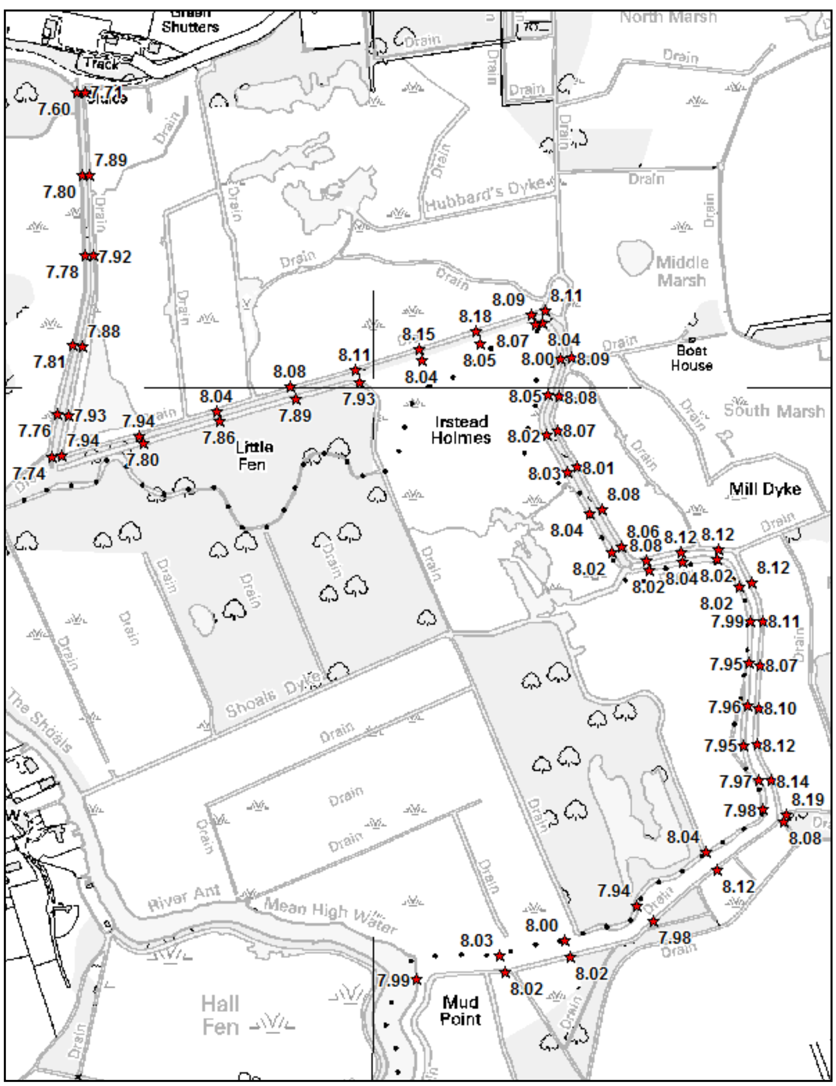
Results

Average pH of all samples: 7.46 (n = 64)
Average pH of Island marsh and sluice marsh dyke samples: 7.57 (n = 23)
Average pH of Hubbard's dyke and Eastern boundary samples: 7.55 (n = 35)
Average pH of meadow marsh dyke samples: 6.56 (n = 6)

<u>6th November 2014 dyke pH survey</u>

Method:

4. Following a period of mixed weather, surface dyke pH was tested at 64 locations using a Hanna HI98129 probe from 9AM to 12PM on 6th November 2014. The probe was calibrated with pH 7 and 10 buffers solutions before and after sampling with a shift of + 0.01pH units at pH7 and +0.04pH units at pH 10 during the day. Water was sampled by inserting the tip of the probe approx. 3cm from the water surface and approx. 50cm from the dyke edge. Areas of algae were avoided and the probe was rinsed with distilled water between each sample. Locations were recorded using a Garmin GPSmap 62 and edited on MapInfo to correct known error. Locations as mapped are accurate to within at most 10m.



Results

Average pH of all samples: 8.00 (n = 69)
Average pH of all internal samples 8.05 (n = 35)
Average pH of all external samples 7.95 (n = 34)
Average pH of Butterfly Conservation internal samples 8.00 (n =14)
Average pH of Catfield Hall internal samples 8.10 (n = 16)
Average pH of Sharp street fen internal samples 8.04 (n = 5)

Interpretation of dyke water pH surveys

5. The pH for the internal system was higher than the pH for the external system for all data sets. This is surprising given the base rich status of the River Ant and relative isolation of the external system from the river. This may imply a source of base rich water within the internal system. It has been proposed that if input from the external system to the internal system was increased through sluice operation, this may help alleviate the base depletion occurring within the internal system, but this data suggests further work is needed to understand what impact this would have on the pH and base status of the internal system.

6. There appears to be decreasing trend in pH within the external system with distance from the dyke connections to the River Ant via Shoals Dyke. This is most pronounced along the dyke to the East of Great Fen and implies that there is poor connection between Great Fen and Barton Broad to the North and that the dykes (and surrounding fen vegetation) intercept much of the base richness before the water reaches the Northern sluice.

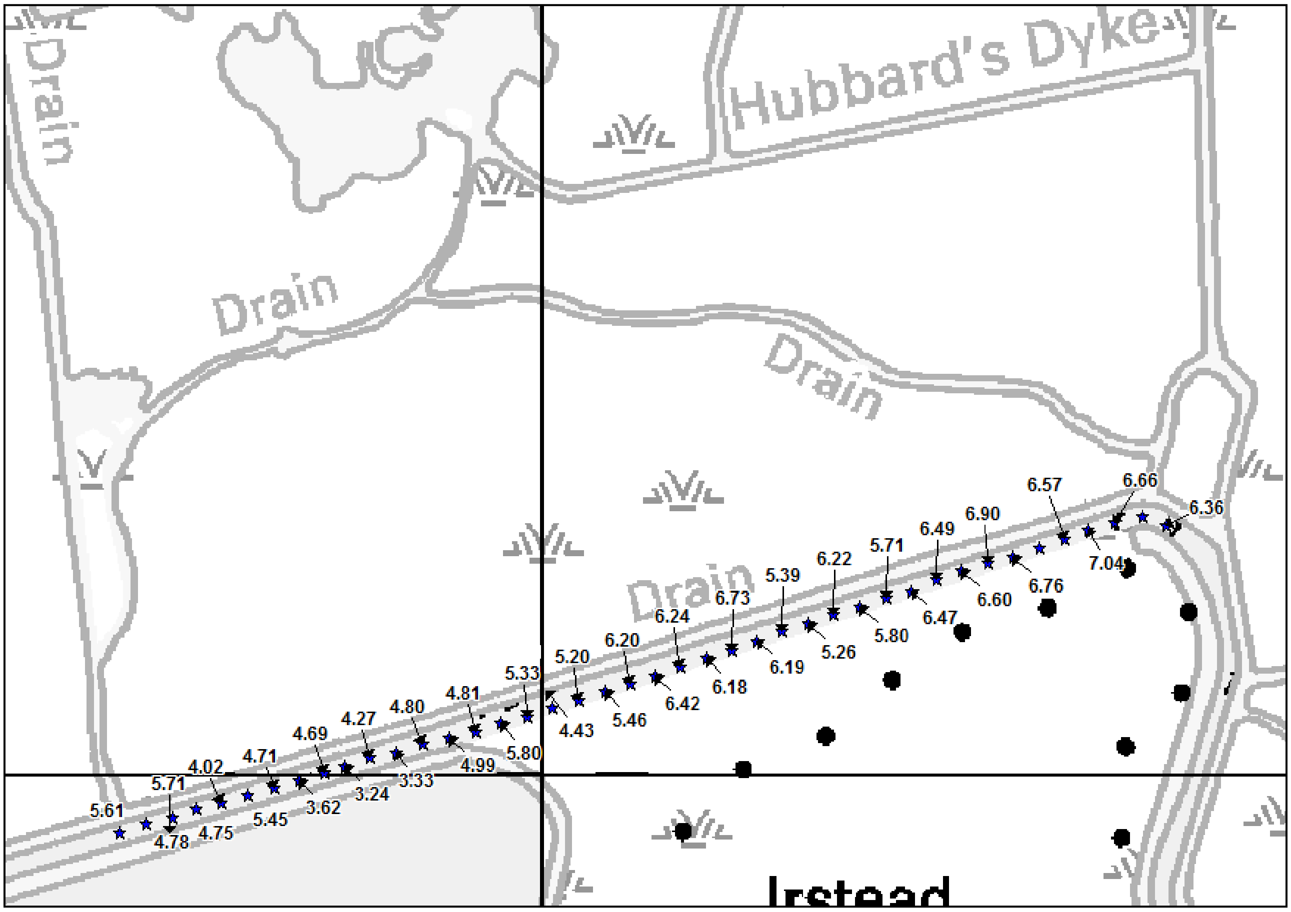
7. The highest pH values are toward Catfield pump and Catfield Hall Estate. There are known connections between the crag and the dykes in these locations and this data supports the hypothesis that base rich crag water feeds the dykes and is important in maintaining their base rich status. There are also some slight increases toward Catfield Staithe, where there is also connection with the crag, though this area is known to be influenced by surface water runoff.

Ditch slubbing pH

8. Dyke pH samples presented above showed increase pH near to the Catfield Mill. There is a known crag connection here (there is crag material on the rond that was dug from the dyke course). To identify if the sediment, as well as the dyke water, showed increased pH in this area that may suggest an extended period of crag input, the pH of the recently slubbed ditch sediment was sampled.

9. Part of the interior rond ditch to the west of Catfield Mill was slubbed during the week of the 13th October. On 6th November 2014, using a Lutron Ph-220S soil pH probe, the slubbings were tested for pH at approximately 10m intervals by inserting the probe 5cm into the surface of the sediment. The probe was washed with distilled water between each sample and the sample was taken from the centre of the rond for each point. Location was recorded by pacing 10m intervals from the fixed

point of a birch tree near the mill to the fixed point of the N-S dyke from Catfield staith and mapped using MapInfo with the aid of an aerial photograph.



Results

10. There is a clear trend of decreasing pH away from the Mill with a possible increase toward the East and the N-S dyke. This is similar to dyke water pH readings shown in 1.1 and 1.3 above and is further indication of a base rich source near to Catfield Mill where there is known to be connection with the crag. The sediment results are likely to demonstrate a long term input (unlike the surface dyke readings that could be short term).

Fen surface water

11. Recent identification of *Potamogeton polygonifolius* in [redacted] has implied that surface pH has changed since the 1980s when *Potamogeton coloratus* was known to occur. To confirm that surface pH was indeed below 7 and within the tolerance range of *P.polygonifolius*, surface water pH tested and mapped.

Method

12. On 15th September 2014, using a Hanna HI 981289 probe, 78 surface pH readings were taken by inserting the probe tip at 3cm depth, areas of algae were avoided and the probe was rinsed between each sample using distilled water. The probe was calibrated with pH 4 and pH7 buffer solutions before and after sampling with a shift of -0.10 at pH 4 and -0.02 at pH7.

Interpretation

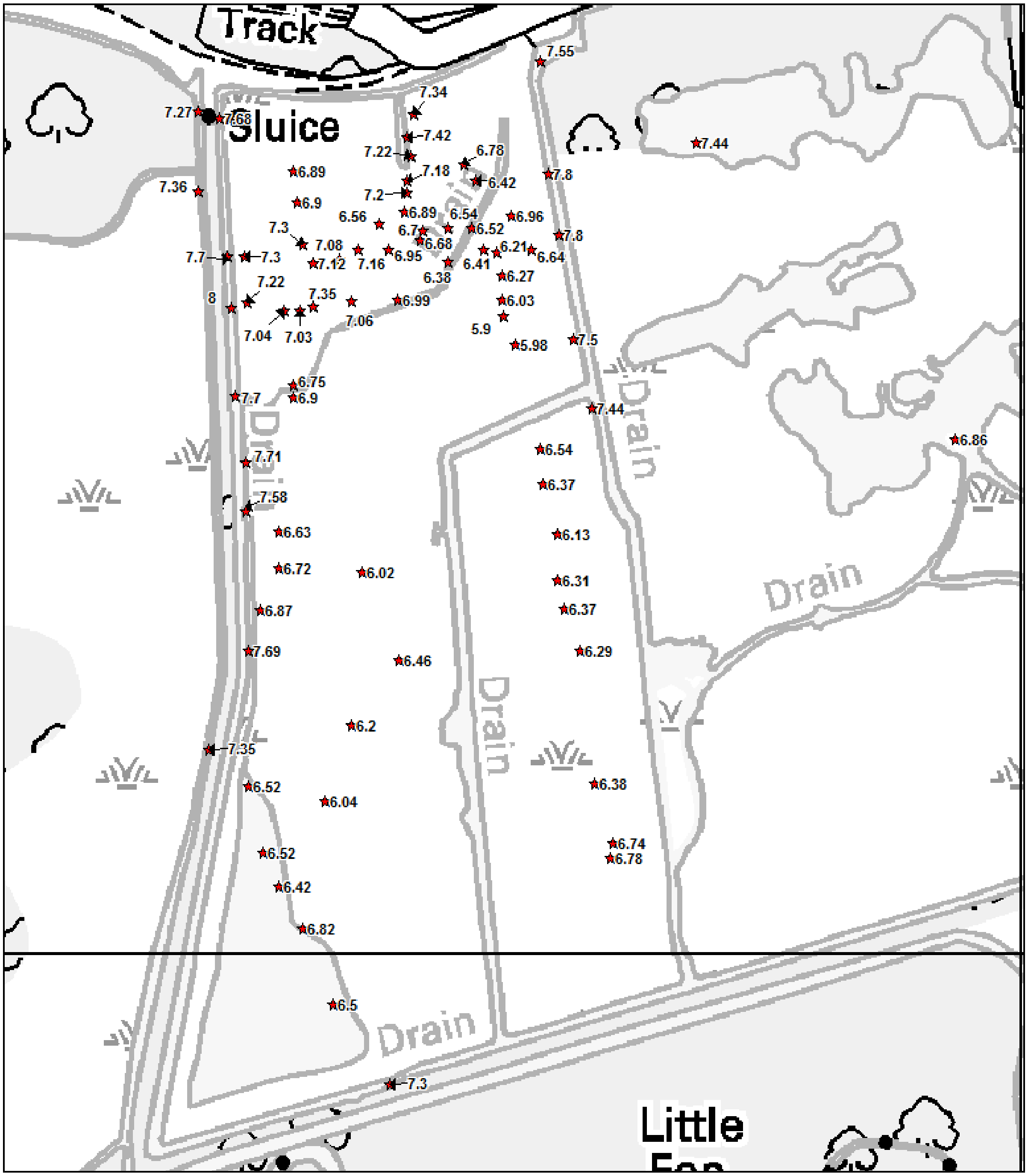
13. The majority of the samples and fen area is within the pH range suitable for *P. polygonifolius*, which was encountered quite widely within [redacted] and there are small areas (most notable the extreme north west corner) where pH is suitable for *P. coloratus*. Despite suitable management and available habitat (bare peat on deer tracks and management operations) there was no *P. coloratus* found here during 3 separate surveys in 2014.

14. Dyke pH is always higher than fen pH and there is some apparent influence from dyke water on pH of adjacent fen, but there is a rapid decrease in pH away from the dykes and therefore a general trend of decreasing pH toward the compartment centres.

15. There is anecdotal evidence of a 'spring' during the 1980s toward the northern part of [redacted] and this area is currently the most alkaline part of the area surveyed. This could indicate a continuing input of base rich water or latent bases within the fen peat from historic input.

16. [redacted] has poor dyke connection, surrounded on three sides (north, east and west) by high peat banks, whereas [redacted] has free connection with dykes with banks in the south west corner (around the turf pond) only. However, this does not appear to have impacted pH, with pH on [redacted] within a similar range to [redacted]. Some areas of the fen with very good connectivity to the ditches are particularly low in pH.

17. Increased connectivity with dykes has been suggested as a measure to increase alkalinity. The data presented here suggests that pH is increased by proximity to dykes, but only marginally and pH drops rapidly with distance from dykes. Creation of new dykes is unlikely to significantly increase pH of fen surface water without an intensive network of new dykes that would be ecological unjustifiable due to loss of open fen to dry banks and interference with the archaeological feature of the undug peat in this area.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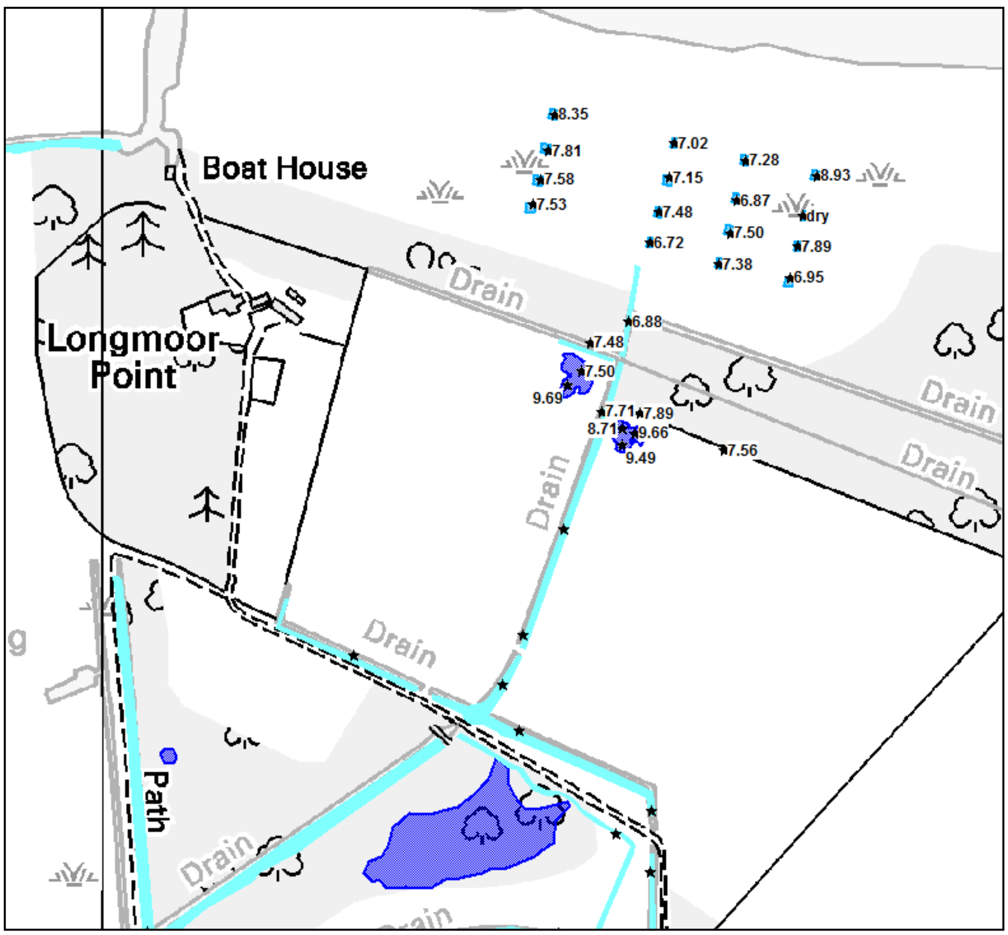
2. pH surveys at Sutton Fen

Introduction

18. In order to better understand water inputs to Sutton Fen, the pH of pools and dykes located on the upland edge of Sutton Fen and extending into the fen compartments was sampled. This particularly focussed on the Sutton Broad area which has been considered with the Environment Agency's groundwater model used to assess two water abstraction licence renewals in the Catfield-Ludham area. The main aim was to determine if there were any indications of direct groundwater inputs to Sutton Fen.

Investigation into pH readings on Sutton Broad



19. Following a period of dry weather, surface dyke pH was tested at 26 locations on the landward edge of, and within, the Sutton Broad area of Sutton Fen. Readings were taken using a Hanna HI98129 probe from 10:00hrs to 16:00hrs on 6th August 2014. The probe was calibrated with pH 4, 7 and 10 buffers solutions before and after every 4 samples. This calibration found a maximum drift of 0.2pH units with an average of 0.1, no correction for pH drift is attempted here. Water was

sampled by inserting the tip of the probe approximately 3cm beneath the water surface and approximately 50cm from the dyke or pond edge at 3 points for each sample site. An average reading was then calculated. Areas of algae were avoided and the probe was rinsed with distilled water between each sample. Locations were recorded using a Garmin GPSmap 62 and edited on MapInfo to correct known error. Locations as mapped are accurate to within at most 10m and mostly to within 1m.

20. Results:

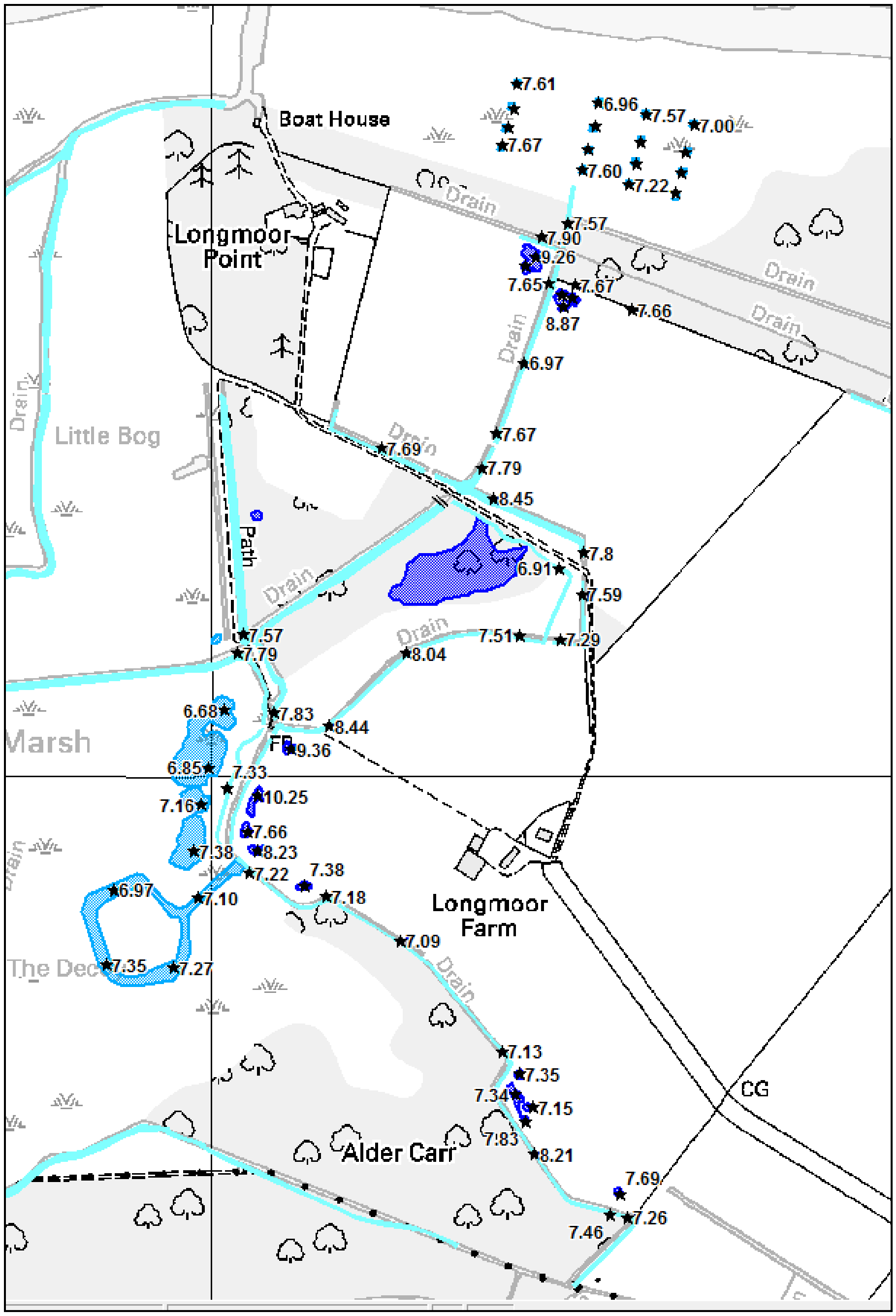
- One sample was too dry to test.
- Average pH of all samples: 7.80 (n = 25)
- Average pH of 'upland ponds': 9.01 (n = 5)
- Average pH of upland dykes: 7.58 (n = 3)
- Average pH of peat dykes: 6.88 (n = 1)
- Average pH of peat turf ponds: 7.50 (n = 15)

Investigations into pH readings on Sutton Fen

21. Following a period of damp weather, surface dyke pH was tested at 55 locations using a Hanna HI98129 probe from 10:00hrs to 16:00hrs on 6th August 2014. The probe was calibrated with pH 4, 7 and 10 buffers solutions before and after every 4 samples. This calibration found a maximum drift of 0.4pH units with an average of 0.1, no correction for pH drift is attempted here. The drift was mostly at the pH 10 end, so it is likely that some of the higher values are overestimates by up to 0.4pH units. Water was sampled by inserting the tip of the probe approximately 3cm below the water surface and approximately 50cm from the dyke or pond edge at 3 points for each sample site with an average taken for presentation below. Areas of algae were avoided and the probe was rinsed with distilled water between each sample. Locations were recorded using a Garmin GPSmap 62 and edited on MapInfo to correct known error. Locations as mapped are accurate to within at most 10metres and mostly to within 1m.

22. Results:

- Average pH of all samples: 7.63 (n = 55)
- Average pH of 'upland ponds': 8.20 (n = 12)
- Average pH of upland dykes: 7.57 (n =22)
- Average pH of peat dykes: 7.37 (n =7)
- Average pH of peat turf ponds: 7.24 (n = 11)



Interpretation of dyke water pH surveys

23. The combined average pH between the two surveys is 7.68. This is a high pH value given that many of the sampling points are isolated from the alkaline influence of the River Ant and Sutton Broad. This provides a very strong indicator for significant alkaline groundwater input. The highest individual pH readings and the highest averages are for the upland ponds and some of the upland dykes. This is not conclusive evidence for groundwater input to these water bodies, but provides

support for the theory that there are alkaline inputs into the site. The sampling points also provide an indication of where to focus further investigations.

24. The peat turf ponds and peat dykes vary from slightly acidic to moderately alkaline and this may imply variation in the significance of different water types to different parts of the site. The upland dyke readings support this, with a variation of over 1 pH unit within <100m in places. This corresponds with vegetation observations, as some dykes support species indicative of base-richness (*e.g. Chara* spp.) whilst other nearby ditches lack such indicator species.

25. The values exceeding pH 9 are remarkable and require further examination. However, these strongly indicate alkaline inputs and potential groundwater upwelling. This is particularly the case for the upland pools that are completely isolated from river water inputs.

26. The pH values exceeding pH 8 on Sutton Broad are surprising and require further examination, the River water that accesses Sutton Broad is below pH 8 so again these high values suggest an alternative source of water input.

27. The pH values below 7 in some parts of the peat fen suggest isolation from base-rich sources, which is surprising given the generally very good connection of the site by ditches and a regularly above surface water level during the winter allowing penetration of river and dyke water into the open fen. It is possible that this could indicate input of base-poor groundwater at the perimeter of the floodplain, as is known to occur at some other sites in the Broads.

28. In summary, the data has highlighted a number of areas for investigation. The remarkably high pH readings for the upland ponds are notable, as well as the more neutral readings within parts of the main fen. However, the hydrology of Sutton Broad and Sutton Fen has been poorly studied. Groundwater inputs could be significant and complex and could be critical in maintaining the complex vegetation communities present. In the context of understanding the risk posed to Sutton Fen from activities such as water abstraction, further investigation to better understand the hydrological regime of Sutton Fen is essential and will be explored further with the Environment Agency and Natural England.

Appendix 10

Information highlighting the presence of groundwater inputs on SSSI Unit 3, Catfield Fen

1. The following provides the best available information highlighting direct groundwater inputs to Catfield Fen.

2. There was a lack of monitoring of groundwater input to Catfield Fen prior to the commencement of local water abstraction in 1967, following increases in licensed amount in 1973 or following issue of new licenses in 1986 and 1988. Therefore there is a lack of empirical evidence to determine if there was or was not significant groundwater input historically and anecdotal evidence becomes the most important evidence available.

3. In 1988, Wheeler detected alkaline water at depth beneath Catfield Fen. In that paper it was not suggested that this water was from groundwater. Groundwater is certainly not the only explanation for the presence of alkaline water at that time, other explanations could be:

   - increased surface flooding from the river in the past, or,
   - latent alkalinity from the clay layer beneath the peat.

4. However, there is no available data to rule out significant groundwater input to Catfield Fen in the past and it is possible that this input provided adequate buffering capacity to maintain the majority of the Catfield Fen area as a calcareous fen. Prior to the 1970s, Catfield Fen was little studied and there is a lack of detailed ecological information. However from Parmenter 1993 it is described by various authors as 'a large reed hole', 'very boggy ground thickly dotted with *Peucedanum palustre'* and 'a wilderness of hidden pulk holes, bottomless mud and jungles of sedge'. These descriptions make no reference to a lack of water or scrub encroachment, the site up until 1970 sounds wet, treacherous and a mixture of open water, wet swamp and sedge beds. After 1970, the descriptions are somewhat different and have continued to the present day with a variety of parties expressing concern about the site drying out, including Jo Parmenter, RSPB, Butterfly Conservation, Natural England, Catfield Hall Estate, Tim Pankhurst, Geoff Nobes and Alec Bull.

5. The change in comment occurred around the early 1970s, shortly after the commencement of local water abstraction in 1970. This in itself is not sufficient evidence to suggest a causative link between abstraction and changes at Catfield Fen. However, there is further anecdotal evidence to suggest historic groundwater input to Catfield Fen which appears to have been largely lost since the 1970s.

6. In a letter to the RSPB in November 2014, Mr McDougall (who owned and managed Catfield Fen from 1945 to 1992) wrote: "There were a few springs as annotated on the enclosed map. Springs A and B were definite.. Spring C is indeterminate as I cannot recall its exact location" "Spring A was an exceptionally strong spring which ran for most of the year except in about 2-3 months in summer" but unfortunately "I don't think any visiting ecologists tested the water or were aware of the hydrology". Despite this there is recollection from Richard Hornby (working for Nature Conservancy Council at the time) of groundwater impacting on vegetation

communities, “there was some very high quality fen vegetation in some of the more open areas. We used to call this a "flushed fen", and as the area is very flat, I think it could only have been flushed by upward movement of groundwater, reaching the surface and moving laterally” sent in an email to RSPB in November 2014.

7. These recollections have been made by contacting 5 people who knew the site in the 1970s, two have not responded and one other (Peter Lambley) could not recall any springs and did not think that there were any though did not rule out some groundwater seepage. It is clear that these accounts do at least raise the possibility that there were significant groundwater inputs to Catfield Fen in the 1970s.

8. There is also some present superficial evidence of historic spring input to Catfield Fen. The pH data shown in Appendix 9 shows raised alkalinity toward the spring A noted by Keith McDougall. Although this pH reduces with depth and it is possible that there is some continued groundwater seepage from the adjoining ‘upland’ at the fen edge. This theory is supported by Tim Pankhurst, Regional Conservation Officer for Plantlife, who has independently observed that the vegetation community in this area and the character of the water (oxygen rich, cloudy) is indicative of groundwater input. He reached this conclusion when visiting the site in 2007 and 2008 and was unaware of Keith McDougall’s recollection of a spring in this area. The RSPB has also observed the cloudy nature of the water in this part of the site, continuing to present, and for that reason carried out pH sampling in this area. This showed a pH consistently above 7 in this area (Appendix 9) decreasing with distance and reaching more typical values around pH 6 found across most of Sluice Marsh and Island Marsh.

9. There is considerable anecdotal evidence that there was significant groundwater input to Catfield Fen before local abstraction commenced 1967 and at least until the 1970s. In 1988 it was shown that beneath the surface there was alkaline, base rich water. In 1991 concerns were first raised by Mr McDougall that local water abstraction may be causing the fen to dry out. Investigations since have concluded that some groundwater input still occurs into ditches and into some parts of the Fen to the East of Catfield Hall (Amec 2012). However, in 2014 it appears that there is no alkaline water under the surface of a major part of Catfield Fen and this strongly suggests a lack of significant current or recent groundwater input to these areas. Despite relatively stable sluice management since at least 1978 and continued intensive management for both commercial crops and wildlife, rapid successional changes have occurred and are occurring at the fen surface. These changes have resulted in the loss of over 1ha of the S24e community, threaten the survival of the UK’s largest fen orchid population and have impacted significantly on the internationally important invertebrate and plant fauna and flora. The AMEC model and main report has predicted a reduction in flow of 37% and a reduction in water level of 4.1cm to cell G, whilst this level of change may be critical in itself, the model and its outputs have been widely criticised by renowned ground water modellers and ecohydrologists and may represent a significant underestimate of the impact of continued and past local water abstraction. With the available information, the RSPB considers that it is likely that historic water abstraction has driven the deterioration of Catfield Fen and that there is a lack of confidence that continued water abstraction would not continue to drive further deterioration.